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A soft and conductive PDMS-PEG block copolymer as a compliant electrode for dielectric elastomers

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Abstract

Conductive PDMS-PEG block copolymers (M_n = 3 – 5 kg/mol) were chain-extended (M_n = 30 – 45 kg/mol) using hydrosilylation reaction as presented in figure 1. Subsequently, the extended copolymers were added to a conductive nano-filler (multi-walled carbon nanotubes – MWCNTs) in order to enhance conductivity. The combination of soft chain-extended PDMS-PEG block copolymers and conductive MWCNTs results in a soft and conductive block copolymer composite which potentially can be used as a compliant and highly stretchable electrode for dielectric elastomers. The addition of MWCNTs into the PDMS-PEG matrix not only increases the conductivity, but also increases mechanical strength by reinforcing the network[1]. However, incorporating MWCNTs into the PDMS-PEG matrix is challenging due to strong van der Waals forces between the MWCNTs[2]. In the present study, MWCNTs were dispersed in organic solvent (N-methyl pyrrolidinone) with 1 wt% of surfactant (Triton X-100). The dispersion of MWCNTs in PDMS-PEG system is shown in figure 2 where MWCNTs (dark areas) are well-distributed in the system indicating an acceptable dispersion although some big clusters appear in the optical microscope image. The conductivity of 4 phr MWCNTs is 10^{-3} S/cm compared to 10^{-1} S/cm of a non-stretchable reference conducting silicone elastomer (LR3162 from Wacker). Furthermore, PDMS-PEG block copolymer with 4 phr MWCNTs (Young's modulus, Y = 0.26 MPa) is softer and more stretchable than LR3162 (Y = 1.17 MPa).

Fig. 1

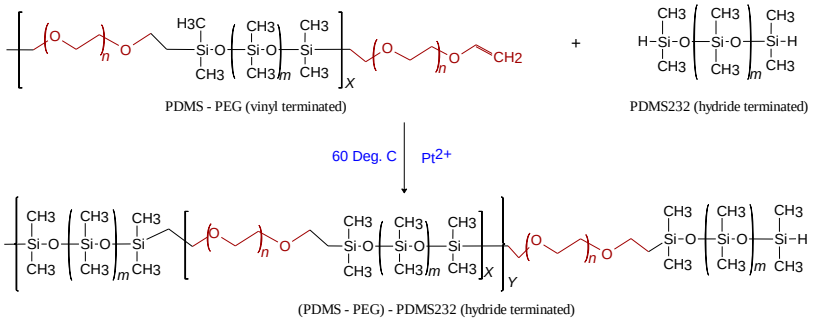

Fig. 2

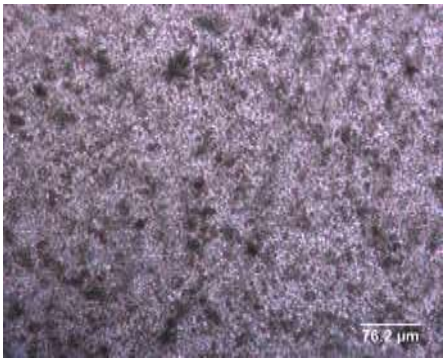

Fig. 1 The hydrosilylation reaction utilized for chain-extended PDMS-PEG block copolymers with 30 ppm Pt. catalyst at 60 °C, where (m=3, 7, 232), (n=4), X and Y are number of repeating units of dimethylsiloxane in PDMS, ethyleneglycol in PEG, PDMS-PEG and (PDMS-PEG)-PDMS232, respectively.

Fig. 2 Optical microscope image of top surface of thin film containing MWCNTs in PDMS-PEG matrix.

References

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